ABSTRACT

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WHAT ARE THE EFFECTS OF A CULTURALLY RESPONSIVE PEDAGOGY ON THE MATHEMATICS ACHIEVEMENT AND ATTITUDES OF SIXTH GRADE AFRICAN AMERICAN STUDENTS IN AN URBAN SCHOOL?

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The purpose of this study was to investigate the effectiveness of a culturally responsive pedagogy in improving African American middle grades students' achievement in attitude toward mathematics. Subjects were selected from two intact mathematics classes. Student gains between pre-test and post-test scores on the Quasar Cognitive Assessment Instrument and the Quasar Mathematics Attitude survey were analyzed using a two-tailed t-statistic. The non-equivalent pre-test post-test control group design was used to test group differences between the control group and treatment group.

This study found that there was no significant difference between the pre-test and post-test scores of the treatment group and control group on the Quasar Cognitive Assessment Instrument. There was a significant difference found between the groups in

attitude toward mathematics. The treatment group did show the more improved attitudes toward mathematics than did the control group.

This study concluded that for this middle school urban group of African American students' the use of culturally responsive pedagogy enabled students to achieve gains at a level comparable to their counterparts whom received traditional instruction. The findings of this study support culturally responsive pedagogy as an instructional method which has the potential to increase mathematics achievement and foster potential attitudes of middle grades African American students in urban school settings.

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Chapter 1

Introduction

Overall, American students perform at lower levels in mathematics than do students in other major industrial nations (Husen 1993). And, when compared to their white and Asian American counterparts, a disproportionately high percentage of African American students are not achieving competitively in mathematics (Secada 1992). Concern has grown about the gap between the mathematical competency of these students and the mathematical skills needed to be competitive in the job market. African American students will need to demonstrate improved performance in mathematics to face the challenges of an increasingly technologically sophisticated society. Current reform efforts have emphasized the need to change the way mathematics is taught and learned so that all students have access to a mathematics education that is rich in opportunities for thinking, reasoning, and problem solving. In order to address the unique needs of culturally diverse learners, educators must begin to take a critical look at the responsiveness of current teaching strategies and how student achievement and attitude are influenced by these strategies.

Rationale

Over a decade ago a crisis in mathematics education for minorities was noted in the 1988 version of Everybody Counts. This crisis was attributed in part to students' lack of knowledge or lack of encouragement to continue studying mathematics. The consequences of these problems range from minorities'low participation rates and poor

performance to their being locked out from entering a chosen career.

A close examination of mathematics curricula and cultural diversity suggests that the current instructional repertoires of teachers be expanded to include the "new" approaches to teaching mathematics that accommodate diverse learners for the 21st century, as suggested by the National Council of Teachers of Mathematics (NCTM). Among the trends that are transforming mathematics curricula is a new emphasis on mathematics applications in the real world and on topics relevant to students' day-to-day experiences (Silver, Smith and Nelson 1995). The NCTM's Curriculum and Evaluation Standards for School Mathematics call for mathematics instruction that emphasizes thinking, reasoning, problem solving, and communication by connecting mathematics to students' life experiences (Silver, Smith and Nelson 1995). This instruction can be effected through a multicultural approach to mathematics teaching. By making the instructional procedures pursued in the mathematics classroom more relevant to the needs of students from diverse backgrounds, teachers will offer students better opportunities to be successful in mathematics. In essence, teachers who use a multicultural approach to teaching mathematics are more likely to stimulate students' interest in and a greater desire for learning.

A multicultural approach to teaching mathematics is not a new phenomenon. For years educators have advocated integrating the cultural backgrounds and life experiences of students into the mathematics curriculum (Anderson 1990, Foster 1989, Stanic 1991, Stiff and Harvey 1988, Tate 1994, Villegas 1991). In general, however, schools continue to utilize a mathematics curriculum that relates more closely to cognitive skills and tasks that are more congruent with mainstream American culture than with other American cultures

of mathematics. This study, by examining the impact of a culturally responsive pedagogy on African American students' achievement in mathematics, will also add to the knowledge base in mathematics education and help test theories embodied in the NCTM's (1991) teaching Standards. In addition, this study may influence the way mathematics is taught to African American middle grades students as well as other culturally diverse groups.

Hypotheses

Ho: 1 There is no statistically significant difference in the mathematics achievement of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Cognitive Assessment Instrument.

Ho: 2 There is no statistically significant difference in the mathematics attitudes of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Mathematics Attitude Survey.

Limitations

Individual subjects for this study were not randomly assigned to either experimental or control groups because of the normal scheduling patterns of the school. However, intact groups were randomly assigned as either experimental or control. Further, sample sizes of groups were below the rule of thumb number of thirty for this type of experiment.

Delimitation

The subjects selected for the study are forty-six sixth grade African American students in an urban school.

Definition of Terms

The following are explanations of terms used in the study:

1. **Culturally responsive pedagogy** as defined in this study is pedagogy that acknowledges the mathematical contribution of Africans and African Americans in the development of mathematics; pedagogy that uses cooperative learning, hands-on mathematics and problem solving exercises. It incorporates students' experiences into the learning activities and makes the use of real life application of mathematics in instruction a major goal (Irvine 1992, Ladson-Billings1990,1992, Cazden and Leggitt, 1989, Au and Jordan 1985).
2. **Student Achievement** is defined as students' proficiency, mastery, and understanding of mathematical concepts, word problems, and computation skills as measured by the Quasar Cognitive Assessment Instrument.
3. **Student Mathematics Attitudes** is defined as student's perception of mathematics usefulness, enjoyment, confidence level and mathematics achievement as measured by the Quasar Mathematics Attitude Survey (Silver et. al 1995).

Chapter 2

Review of the Literature

This chapter provides a survey of important literature related to this study which seeks to determine the effects of culturally responsive pedagogy on the mathematics achievement of sixth grade African American students. There is an expanding, although still incomplete body of empirical and theoretical literature dealing with what some educators have come to call a "culturally responsive pedagogy." In brief, this literature confirms that teachers can have a positive impact on the academic growth of minority students. To be successful, teachers need not be members of the students' cultural group, although having similar cultural experiences often facilitates instruction. Good teachers, however, must be sensitive to the cultural characteristics of the learners, and have the skills needed to accommodate these characteristics in the classroom (Irvine 1992, Asher 1991, Banks 1995, Malloy 1997). The chapter is divided into two sections: the theory of cultural discontinuity and related studies; and studies on the use of culturally responsive pedagogy in teaching mathematics.

Theoretical Framework

Many studies show that traditional mathematics instruction has not been effective with minorities, particularly African American students (Porter 1989, Stodalsky 1988, Tate 1994). Stiff (1990) asserts that African American students enter school as preschoolers with the same knowledge as their white counterparts but are not as likely to succeed in formal reasoning. He contends that:

> By the time African American students enter kindergarten, virtually all of them are prepared to succeed in the school mathematics they will face. Since the difficulty that African American students encounter in learning mathematics does not reveal itself before formal learning begins, it may be attributable to the experiences that African American students undergo in the school setting. Perhaps school mathematics becomes the obstacle to success in the mathematics education to success process (p. 154).

Hilliard (1988) posited that although the traditional school mimics the traditional culture style of European Americans, "this is not the only way to teach" and "it may not be the best way to teach" (p.7). Irvine (1990) also stated that "because the culture of African American children is different and often misunderstood, ignored, or discounted, African American students are likely to experience cultural discontinuity in schools, particularly in schools in which the majority, or Eurocentric persons, control, administer, and teach."

There are numerous studies that offer explanations for minority children's poor performance in school. Some of these explanations suggest a deficiency in the children themselves and/or in their home experiences. Other explanations reject the notion of deficiency and redirect attention to educational practices that are suspected of reinforcing inequalities (Villegas, 1991).

However, the theoretical framework for this study is provided by the theory of cultural discontinuity and the importance of incorporating a culturally responsive pedagogy in improving the mathematics achievement level of African American students. The theory of cultural discontinuity states that traditional modes of instruction and curriculum do not take into account the cultural makeup of most learners, therefore resulting in a mismatch between the home and school environment. Several studies have tested this theory.

Cultural Discontinuity Studies

Stiff and Harvey (1988) conducted a study that explored the relationship between African American students' experiences and the impact of these experiences on how students learn mathematics. The researchers found that teachers often negated the contributions of African American students who attempted to draw connections between their mathematics lessons and their lived experiences. Other scholars (Silver, Smith and Nelson 1995, Tate 1994, Glaser and Silver 1994) described how a group of African American middle school students were penalized for integrating their home experiences with the mathematics problem solving process and not solving the problem using a white middle class frame of reference. Tate (1994) asserted that failing to provide African American students with mathematics curriculum, instruction, and assessment that embrace their existing knowledge and experience is a major obstacle to achieving equity in mathematics education. Other scholars (Rowser and Koontz 1995) have acknowledged that mathematics teaching for African American students should reflect their lived experiences and cultural background.

Several versions of the theory exist, each explaining a specific area of disjuncture. Attention has been paid to differences in dialects and in cognitive styles (Villegas 1991). More recently, however, the focus of attention has shifted to subtle differences in the ways that language is used at home and in school, and to the failures in communication resulting from these differences.

Research (Heath 1983, Villegas 1991) has shown that although students and teachers in a given classroom may speak the same language, they sometimes have different ways of

using it. Children whose language use at home and in their immediate community corresponds more closely to the way in which it is used in the classroom have an advantage in the learning process. For these students, prior experience transfers to the classroom and facilitates their academic performance. This seems to be the case for white, middle-class, Anglo-American students. In contrast, minority children frequently experience discontinuity in the use of language at home and in school. They are often misunderstood when applying familiar patterns of language use to classroom tasks. Of what use is prior experience to these children if their established ways of using language and making sense of the world are deemed unacceptable or prohibited in the classroom? This discontinuity is a major source of academic problems for minority children.

Another example of the incongruity that can occur in schooling was provided by Leap (1988) in a study of culturally-linked approaches to mathematics problem solving among fifth and sixth grade youngsters of the Ute tribe of northeastern Utah. Students often viewed word problems as real situations before they attempted to solve them. Thus, when a Ute student was asked to determine how much money his brother would have to spend on gasoline if he wanted to drive his pick-up truck from the reservation to Salt Lake City, the student did not attempt to solve the problem as it was posed. Instead, he assessed the truth value of the problem and answered, "My brother does not have a pick-up truck." Evidently, assessments of truth value are a common part of everyday life on the reservation and affect decisions about personal conduct as well as about tribal affairs more generally. The willingness to engage with mathematical problems that contain hypothetical situations would seem to be a requirement for success in a mathematics education that stresses problem

solving. This example illustrates that making such education accessible to culturally diverse populations requires helping students negotiate transitions among frames of reference (Silver, Smith and Nelson 1995).

Substantiation for the theory of cultural discontinuity has been found in the research of Schoenfield (1991) and Silver, Shapiro and Deutsch (1993). Their studies suggested students view mathematics as a domain which is disconnected from sense making and the world of everyday experience. Silver, Shapiro and Deutsch (1993) found that when middle school students were asked to provide interpretations for an answer to a division problem dealing with a real world situation, their responses dealt more with technical concerns than with sense making.

The studies presented above provide evidence of the difficulties of cross-cultural communication and make a convincing case for the premise that discontinuity between home and school environments prevents minority students from succeeding in school. The solution to cultural disparities between home and school is not necessarily having the school duplicate the cultural conditions of the home. Instead, what most advocates of the cultural difference theory propose is a model of mutual accommodation in which both teachers and students adapt their actions to the common goal of academic success with cultural respect (Villegas 1991, Tikunoff 1990, Cazden and Leggett 1989).

The home-school discontinuity theory of educational failure has received a fair amount of criticism (Hilliard 1988 and Ogbu 1992). Hilliard, for example, admitted that cultural disjunctures between home and school influence the learning process in important ways. However, he argued that because all children are flexible and adaptable, cultural

disparity alone cannot completely explain the low school performance of minority children. Hilliard proposed that the school failure of minorities is due to inequalities in the delivery of instruction, whereby minority students are treated less favorably than their white, middle-class counterparts. Conversely, Villegas (1991) argued that proponents of the home-school discontinuity theory, while claiming to offer fundamental solutions to this problem, leave unexamined the social inequities underlying the problem of school failure on the part of minority children. She argued that the root of the problem stems from a struggle for power in our economically stratified society and specifically criticized the theory for its failure to address the question of cultural status: Why the language and culture of "mainstream" white America have higher status in our society than do those of minority groups.

Despite the criticism of the cultural difference theory, the explanation justifies shifts in multicultural education paradigms and the exploration of these paradigms, thus opening the door for innovative programs addressing the mathematics performance of culturally diverse students. The theory suggests that instruction involving African American students must be responsive to their cultural norms and experiences.

Culturally Responsive Pedagogy

A culturally responsive pedagogy builds on the premise that how people are expected to go about learning may differ across cultures (Villegas 1992). Thus to improve the mathematical skills of minority students, African American students in particular, may involve modifying the means used to achieve learning outcomes, not changing the intended outcomes. A culturally responsive mathematics pedagogy provides the academic environment that fosters diverse students' learning capabilities, enabling them to achieve

success in mathematics. Several studies have been conducted to explore the relationship between African American students' experiences, culture, and school mathematics. This section describes some of these studies as well as examples of programs employing culturally responsive teaching methods that have been effective in increasing the mathematics achievement of African American students.

One study conducted by Baugh (1994) recommended that culturally responsive pedagogy be implemented in the mathematics classroom. He suggested that mathematics programs should select problem-solving topics that interest the student and develop team projects to solve problems based on their cultural background. Part of his study included assessing African American students' perceptions of their mathematics performance. All students were asked to respond to a series of open-ended questions about their attitudes toward mathematics. For example, "What influences your mathematics performance?" and "Do you see mathematics as being necessary in your life?" The students' perceptions of mathematics were intricately related to their surrounding at home, in school, and in their communities. Most of the students surveyed revealed that their mathematics classes did not make sense and that they could not relate to the problem. In order to learn a new idea in mathematics, the learner must be able to relate it to previously acquired knowledge. In other words, the student must be able to connect the idea to their background experiences. Thus when students were given problems to which they could relate, they were more successful in math.

Other scholars have explored the relationship between African American students' experiences and mathematics. For example, Stiff and Harvey (1988) found that African

American students who attempted to center their lives and experiences within the process of acquiring knowledge about mathematics risked being put down by teachers for focusing on "extraneous matters." Tate (1994) asserted that failing to provide African American students with mathematics curriculum, instruction, and assessment centered on their experiences, culture and traditions was a major obstacle to achieving equity in mathematics education.

Another study conducted by Malloy (1994) substantiated the importance of infusing African heritage and culture into teaching mathematics to African American students. She found that many low achieving African American middle school students overcame their impediments to learning mathematics when it was connected to their cultural heritage in classroom activities. These students were generally performing at a high level in a community where the achievement of African American students, as a whole, fell well below the achievement level of the general population. They were involved in mathematics instruction that included small-group, cooperative learning environments and lessons that integrated students' life experiences into the learning process. As a result of this type instruction, the mathematics achievement for participants improved dramatically.

Harvey and others engaged in ethnographic research to describe the effectiveness of a multicultural mathematics television series on minority students'attitudes and achievement levels attained in mathematics. The study was conducted in grades three through six over a ten-week period. The authors concluded that using a culturally responsive pedagogy was instrumental in increasing mathematics learning for African American and Latino students. Overall scores improved significantly from pre-test to post-test on a measure of students'

social and mathematics attitudes related to series goals, and on a measure of students' attitudes toward television programs about mathematics. Based on the results of the study, one suggestion made was that since the show segments featured African American and Latino students, and was well received, more types of multicultural education programs of this type be produced. Another suggestion was that the program guides should include more ways to develop positive social, cultural, and mathematics attitudes in a classroom setting since many teachers rated the program very high in these areas but focused mainly on math content in related classroom activities they conducted.

Recent works by Ladson-Billings (1990, 1992) on culturally relevant teaching further acknowledged that instruction should reflect the experiences and interests of African American students. She conducted research on eight teachers who taught African American students. Her focus was on what it takes to teach African American students effectively. Her analyses of effective elementary school teachers of African American students in urban schools suggests the importance of "culturally relevant" teaching, in which important characteristics of the students and their culture are linked to classroom instructional practice and expectations of student outcomes. This approach was found to be consistent with the other teachers surveyed for the study.

Programs using culturally responsive pedagogy

This section discusses several well-documented programs of intervention based on culturally responsive pedagogy in teaching mathematics to diverse students.

The Algebra Project is one example of a successful project that bridges the gap between schools and minority students. The program is instrumental in helping African

American middle school learners become mathematically literate, competent, and motivated to master the college preparatory high school mathematics and science curriculum. Two components of the program are worth noting. First its lessons are constructed to reflect the real-life experiences of the students learning Algebra. For example Moses, the creator of the Algebra Project, used the design of the urban transit system to illustrate the concept of positive and negative numbers in algebra. Second, the project bring together parents, community volunteers, and school administrators to build a broader community that understands that it takes the collective efforts of many to ensure students' learning.

The Algebra Project uses a five step process to help students and parents undersand algebra: (1) a physical event familiar to everyone in a particular setting, giving a relevant context for the mathematics, (2) a picture or model of the event, (3) a description of the event in the students' language, (4) a description of this event in regimented English, and (5) a symbolic representation of the event (Moses et al. 1989).

A second example of culturally responsive pedagogy that is currently being tested is the QUASAR project. QUASAR stands for Quantitative Understanding: Amplifying Student Achievement and Reasoning. QUASAR was developed to meet current reform efforts in mathematics. The reform efforts emphasized the need to change the way mathematics is taught and learned so that all students have access to a mathematics education that is rich in opportunities for thinking, reasoning, and problem solving. The QUASAR project is aimed at improving mathematics instruction in the middle grades in ways that are compatible with the NCTM standards. The Quasar project is currently being used at six school sites across the country. The common denominator that all schools have

is that they serve disadvantaged students and have diverse student populations. Two of the goals of Quasar is to boost the mathematics performance of students in low-income areas by teaching them higher-level math skills by relating mathematics to students' life experiences and relating mathematics to the cultural heritage of students.

Preliminary analysis of the data from the overall QUASAR project indicated that the project has already had a major impact at the development sites in only a short period of time. Children were engaged in thought provoking relevant mathematics that involved dialogue and writing, contrary to the traditional modes of teaching. Some of the early indicators of the project's success included increased school attendance, increased engagement in optional math-related activities (e.g., after-school clubs, math competitions) and increased enrollment in Algebra at the eighth-grade level. With respect to performance, indicators of project impact on students included the success of schools and individual students in district or regional mathematics competitions and marked improvements in student performance on Quasar's project wide assessment and, in some cases, on sections of externally mandated standardized achievement tests dealing with applications, problem solving and conceptual understanding (Silver, Smith and Nelson 1995)The "Marva Collins Academy" is another program that utilizes a culturally responsive pedagogy. Marva Collins' success with African American students in Chicago has not been the subject of detailed ethnographic research. Nonetheless, her work is widely publicized. Her teaching is described and analyzed both in scholarly journals and the popular press (Collins and Tamarken 1982). Many attribute Ms. Collins' success to factors typically associated with effective teaching, such as high expectations for the students and active teaching behaviors

as well as her ability to establish cultural congruence between teaching activities and the experiences of the students at home and in their communities.

Her classroom environment is reflective of many African American families. She provides a caring, nurturing climate that is flexible and non-restrictive. Her classes are structured so that students work closely together in small cooperative learning groups. Research supports that social learning is an integral part of the school experience for many African American students. For Ms. Collins, learning is more important than competition, which she tends to minimize in her school.

She incorporates the features of a culturally responsive pedagogy in her teaching by accepting the natural language of her learners and using it as a vehicle for learning. For example, analogical comparison often used in traditional African American speech are evident in Ms. Collins' teaching. Jive talking and the use of rap is accepted as a viable means of communication in her classroom. By capitalizing on the students'language resources, Ms. Collins is able to engage the students in tasks they might other wise reject. Also important, by using the language of the students, she lets them know that their ways are valued and respected in school, thereby supporting the development of positive cultural identities. Still another link between home and school is Ms. Collins' classroom use of interaction patterns commonly found in the African American church. These patterns include "choral and responsive reading, audience participation, use of analogies, and the identification of a moral or personal message from the passage read." Collins' work is an example of how academic achievement and cultural competence can be merged. By engaging her students in culturally responsive learning activities, Collins has improved her

students' academic performance. Most of all, she has helped her students maintain and strengthen their sense of identity and personal worth. The three examples of culturally responsive pedagogy presented above demonstrate that it is possible to design instruction which promotes learning by building on students' cultural experiences. The effectiveness of a culturally responsive pedagogy is based on the teachers' ability to create meaningful classroom activities that take into account students' background experiences. Utilizing a cultural responsive pedagogy requires a paradigm shift for educators in how we teach diverse learners.

Classroom example of culturally responsive pedagogy

Kay Toliver, an African American teacher, gained national recognition for her use of cultural knowledge to create rewarding classroom experiences for diverse students. Her students consisted of African American and Latino ethnicities. In addition to her use of strategies typically associated with effective teaching, such as high expectations for the students, high rates of time on task, and active teaching behaviors, Ms.Toliver also combined math and communications arts skills to inspire and motivate her students and her classroom was characterized by constant mathematics dialogue between teacher and students. Underlying her success was her ability to establish cultural concrete links between classroom instruction and the experiences of the students; thereby employing a culturally responsive pedagogy to teaching mathematics. She also incorporated the learning styles of the students in her teaching; thereby fostering cultural norms by using cooperation, flexibility, collective responsibility, autonomy, and strong adult leadership. She also minimized competition and encouraged the students to help one another by engaging them

in carefully structured cooperative group activities. She drew connections between the knowledge students brought to school and the mathematics they were asked to learn. This teacher developed a mathematics program that enabled each child to construct connections between his or her own informal knowledge and new knowledge by taking the background culture of the child into consideration so that the context in which mathematics is embedded is meaningful to the child; she provided mathematical problems that involved real world situations and other settings relevant to middle school students. Thus, the culture of each child was used to structure the learning environment so that he or she is able to construct relationships and learn mathematics with understanding (Carey et al. 1995).

Summary

The theoretical underpinnings of this study are found in the literature on cultural discontinuity and culturally responsive pedagogy. Cultural discontinuity theory has been used to explain the poor academic achievement among low-income students and students of color. African American students in particular often have difficulties in school because cultural knowledge within their community conflicts with the schools culture. The literature clearly indicates that there is a mismatch in the culture of the school, its instructional programs and the culture of these students. Current reform efforts have emphasized the need to change the way mathematics is taught and learned so that all students have access to a mathematics education that is rich in opportunities for thinking, reasoning, and problem solving (Gilbert and Gay 1985). Because of the discontinuity between home and school, the National Council of Teachers of Mathematics (1991) has urged mathematics teachers and schools to focus on new ways for improving the quality

of mathematics instruction by drawing connections between the mathematics taught in school and the experiences of the learners.

One solution to address the discontinuity that exists between home and school has been the theory of culturally responsive pedagogy. Culturally responsive pedagogy is instruction that recognizes and includes culture and life experiences of students in the learning process. One feature of a culturally responsive pedagogy is to make mathematics relevant to students by making connection between the mathematics taught in school and the experiences of the students. Culturally responsive pedagogy promotes learning by building on students' cultural experiences. In terms of increasing the mathematical achievement level of African American students, implementing a culturally responsive pedagogy that provides opportunities for students to see mathematics as having relevance to their lives, interests and culture can prove to be an effective teaching strategy for African American students.

CHAPTER 3

Methodology

Introduction

The purpose of this study was to determine the effects of a culturally responsive pedagogy on middle grades African American urban learners. More specifically, the study sought to answer this question. The information contained in this chapter delineates the methods used in completing the study.

Research Method

The method of research used for this study was quasi-experimental. The rationale for selecting this design was based primarily on two limitations: lack of randomization and small sample sizes. The research design employed was the randomized pre-test post-test control group design (Vaillant & Vaillant 1982). The randomized pre-test post-test design is the best approach to use when random selection and assignment are not possible.

The randomized pre-test post-test control group design required the researcher to first compute the amount of gain from the pre-test to the post-test for both the experimental and control groups. The next step was to compare the mean difference of the experimental group with that of the control group to determine whether the treatment had caused a significant difference between the groups. Both groups were administered - The QUASAR Cognitive Assessment Instrument (QCAI) and the Quasar Mathematics Attitude Survey- which were scored and compared with the same test after the treatment with the

experimental group.

The model for the research design is illustrated below:

GROUP	Pre-test	Independent Variable	Post-test
R	(E) Y1	X	Y2
	(C) Y1	-	Y2

The pre-test post-test design can be viewed as an advantage over the post-test only control group design because it provides additional information about the groups prior to the application of the treatment. One limitation to providing a pre-test before the treatment is that the subjects may become aware of certain events that may subsequently affect their responses on the post-test. However, since testing is a normal part of the school environment, pre-testing does not provide a serious threat to the external validity of the results (Vaillant and Vaillant, 1982).

Study Setting and Participants

The school used for this study was an Atlanta urban public middle school located in a middle class community. The school is comprised of sixth, seventh, and eighth grades and has a total enrollment of 1200 students, of which 310 are sixth graders. About half of the 310 sixth graders scored below the 50th percentile on the ITBS-M (Iowa Test of BASIC SKILLS) in statewide testing in 1995. Ninety-five percent of the students are African Americans.

The study group consisted of forty-seven African American students. Twenty-three subjects comprised the control group and twenty-four comprised the experimental group. Each group was administered both pre and post tests.

Instruments and Data collection

The instruments used in the study were the QUASAR Cognitive Assessment Instrument (QCAI) designed by the Quasar Project - University of Pittsburgh and Quasar Mathematics Attitude Survey. The QUASAR performance tasks consisted of a set of open-ended tasks that assess mathematical reasoning, mathematical problem solving, the understanding of mathematical concepts and communication of mathematical explanation or justifications (Silver and Lane, 1993). Whenever possible, the problem sets used were related to the student's background and experiences. Most of the problems used did not have one-answer solutions; rather, they were open to multiple interpretations and strategies and may have had more than one answer. The goal of the problem sets was to get students to think, reason and justify their answers to the problems, which could have several different answers.

One of the goals of the Quasar project is to make mathematics more relevant to the lives and cultures of students, thereby providing real-life, task-oriented problems that draw on the everyday lives of the student population, which is critical in this effort. Figure 1 below illustrates one such problem.

FIGURE 1

Busy Bus Company Problem

Yvonne is trying to decide whether she should buy a weekly bus pass. On Monday, Wednesday, and Friday, she rides the bus to and from work. On Tuesday and Thursday, she rides the bus to work, but gets a ride home with her friends. Should Yvonne buy a weekly bus pass? Explain your answer.

Busy Bus Company Fares

One Way	$1.00
Weekly Pass	$9.00

This problem is a prime example that illustrates how schools can incorporate the relevance of school mathematics to the lives of the children they teach by providing "real world" contexts for mathematics problems. "Real World" solutions for those problems must also be considered.

The QUASAR project uses an alternative assessment instrument for testing students called the QCAI (Quasar Cognitive Assessment Instrument). The assessment instrument differs from traditional quizzes and unit tests in that it uses a holistic rubric scoring approach. In a holistic scoring procedure, each student's response to an open-ended task is assigned one numerical score level based on a set of specified criteria developed by a group of classroom teachers, mathematics educators, and assessment experts (Cai et. al. 1995). This type of performance assessment, which consists of open-ended mathematical problems, appears to be closely aligned with the new goals of mathematics instruction espoused by mathematics educators (Silver, Smith and Nelson 1995). For example, Figure 1 shows the summary descriptions of the criteria specified for each of the five score levels for the problems developed by and used in the QUASAR Cognitive Assessment Instrument (QCAI) (Lane 1993).

FIGURE 2

Summary Descriptions of the Criteria Specified for Each of the Five Score Levels for the Performance Tasks and QCAI.

Level 4: Student responses demonstrated a full understanding of the question and his/her work demonstrated the complete steps involved in the problem solving solution thereby yielding a correct answer.

Level 3: Student responses indicated a full understanding of the question and correct understanding of the problem solution, however several steps were incorrect.

Level 2: Student responses indicated some understanding of the question and some correct understanding of problem solution.

Level 1: Student responses indicated some understanding of the question and little or no understanding of the problem solution.

Level 0: Student responses demonstrated no knowledge and understanding of the question of the problem solution.

The QCAI uses both holistic and qualitative analytic frameworks to analyze student responses to the open-ended tasks. Both holistic scoring procedures and qualitative analytical frameworks draw on recent advances in cognitive psychology which highlight the importance of moving beyond the correctness of the answer to a task to examining solution processes, including mathematical communication, solution strategies, and mathematical errors (Silver and Lane 1993). However, the qualitative analytical framework is more descriptive in nature than assigning a level or score and can provide rich information to help guide instruction. It emphasizes students' communication skills in terms of communicating mathematically and in analyzing their capacity to solve complex mathematical problems.

Since the QCAI answers took the form of written responses, the data was nominal. The data was analyzed using a rubric instrument. The scoring of the data was based on the composite score of each assessment.

The Quasar Mathematics Attitude Survey was used to measure students' perception of mathematics usefulness, enjoyment, and confidence level and mathematics achievement. All students were given a total of sixteen statements in which their answers ranged from SA-Strongly Agree to SD-Strongly Disagree. For example, "Mathematics is my favorite subject in school." A likert scale was used to measure attitudes toward mathematics. An example of the mathematics attitude survey can be found in the appendix.

Data Analysis

The two-tailed t-test was used to determine if significant differences existed in the posttest performance of the experimental and control groups. The groups' mean scores on these tests will be computed to determine if there is a significant difference between the

means of the experimental and the control group.

The following hypotheses were tested:

Ho: 1 There is no statistically significant difference in the mathematics achievement of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Cognitive Assessment Instrument.

Ho: 2 There is no statistically significant difference in the mathematics attitudes of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Mathematics Attitude Survey.

Treatment

The treatment (instructional activities) for the experimental group consisted of open-ended mathematical tasks and multicultural activities that promoted problem-solving skills. The open-ended tasks provided students with opportunities to think, reason, and communicate their answers to the tasks given. The tasks were designed to engage students in matters of conceptual understanding or mathematical reasoning or problem solving situations within a cultural context. Emphasis was placed on enhanced levels of student discourse about mathematical ideas rather than simply providing a correct answer without any accompanying explanation. All of the tasks were solved using cooperative groups and collaboration efforts. Proponents of cooperative learning assert that this type of mathematics pedagogy has features that make it highly likely that this type of classroom instruction provides supportive learning environments for culturally diverse students (Silver & Lane

1993, Garcia 1991).

The treatment lasted for eleven weeks with two weeks for testing and scoring. Testing lasted for two days since this was a new assessment method for the students, and ample opportunity was given for students to respond to each task.

Summary

This chapter has presented the methods used to investigate the effects of a culturally responsive pedagogy on increasing the mathematical achievement and attitudes of sixth grade African American students. Included were descriptions of the research design, the research setting, the subjects, the experimental treatment, and procedures for data collection, data treatment and instrumentation.

Chapter 4

Presentation and Analysis of Data

Introduction

There is perhaps no greater problem in American education than the lagging academic achievement of minority students, particularly African Americans. Several studies have been conducted in an attempt to explain why this disproportionate gap exists (Secada 1992, Dossey, Mullis, and Jones 1993, Oakes 1990, Tate 1994). Unfortunately, few of these studies have resulted in strategies for combating the obstacles that exist for African American students in mathematics. One area believed to hold promise is the emerging concept of culturally responsive pedagogy, a pedagogy that uses the culture, history and perspectives of students as an integral part of educational practice (Bartolome 1994, Ladson-Billings 1994).

This study investigated the effects of a culturally responsive pedagogy on the mathematics achievement of sixth grade African American students in an urban middle school. The research problem was to determine if there was a difference between the mathematics achievement levels and attitudes of sixth grade African American students who received culturally responsive pedagogy and students who did not receive such instruction.

This chapter presents the results of the data analysis. Two null hypotheses were tested: The first stated that there is no statistically significant difference in the mathematics

pedagogical strategies and students who are not. The second hypothesis stated that there is no statistically significant difference in the mathematics attitudes of students taught mathematics through culturally responsive pedagogical strategies and students who are not taught using this method. Data are presented and analyzed below for each hypothesis.

Presentation and Analysis of Data: Hypothesis I

Hypothesis 1

Ho: 1 There is no statistically significant difference in the mathematics achievement of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Cognitive Assessment Instrument.

The researcher tested hypothesis I to determine if any gains in achievement might exist as a result of implementing a culturally responsive pedagogy. As part of the analysis of data, the level of significance was set at .05. The researcher applied the **t-test** for independent samples to test the hypothesis. The maximum score that could be attained on the Quasar Mathematics Achievement Test was 100. The mean achievement score of the 24 students in the treatment group was compared to the mean achievement score of the 23 students in the control group. The results of the mean scores for the two groups are recorded in Table 1. As can be seen in Table 1, the computed t-value of 1.16 with a probability level of .05 with 44 degrees of freedom is less than the critical t-value of 2.021. Therefore the null hypothesis was retained.

Table 1

DIFFERENCES IN MEAN GAIN SCORES ON THE QUASAR MATHEMATICS TEST FOR THE TREATMENT AND CONTROL GROUP

	Mean	Standard Deviation	T-value	df	2-tail prob.
Treatment group	**3.2174**	**4.6321**			
			1.16	**44**	**.2535**
Control group	**1.2174**	**6.7954**			

Hypothesis 2

Ho: 2 There is no statistically significant difference in the mathematics attitudes of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Mathematics Attitude Survey.

Students' attitudes were surveyed before and after employing the culturally responsive method of instruction using the Quasar Mathematics Attitude Survey. Using data gathered from the surveys, Hypothesis 2 was tested to determine if significant differences existed between the post test means of the attitude scores of the control and treatment groups. A separate two-tailed t-test was performed to measure mean differences

in attitude between the treatment group and the control group. Test results are recorded in Table 2. The t-statistic for independent samples was used to find the calculated **t** = 2.83 which was greater than the critical t = 2.02 at a computed **p**= .008 level of significance. Therefore the null hypothesis was rejected.

Table 2

MEAN DIFFERENCES IN ATTITUDE BETWEEN THE CONTROL GROUP AND TREATMENT GROUP ON THE QUASAR MATHEMATICS ATTITUDE SURVEY

	Mean	Standard Deviation	t-value	2-tail Prob.	Mean Difference
Treatment Group	**3.4167**	**.750**			
			2.83	**.008**	**.4962**
Control Group	**2.9205**	**.403**			

Summary

The post-test results for the treatment and control group did not reveal a statistically significant difference in mathematical achievement as a result of using a culturally responsive mathematics pedagogy. Null hypothesis 1 was retained.

Hypothesis 2 addressed the effects the treatment might have on students' attitude towards mathematics. The mathematics attitude survey results indicated that differences in the attitudes of students in the treatment group were significantly different from the students in the control group. The null hypothesis was therefore rejected.

Chapter 5

Summary, Conclusions, Discussions and Recommendations

Summary

The mathematics achievement of urban African Americans and Hispanics is alarming when compared to their white and Asian counterparts. Although African American and Hispanic children enter kindergarten with the same basic intellectual competencies in mathematical thought and cognitive processes as their white and Asian counterparts (Stiff and Harvey 1988), from age nine they do not perform as well as whites on national surveys of mathematical achievement (Secada 1992, Stiff and Harvey 1988). This gap continues to widen through high school (Oakes 1990, Secada, 1992).

Current reform efforts have emphasized the need to change the way mathematics is taught and learned so that all students have access to a mathematics education that is rich in opportunities for thinking, reasoning, and problem solving. Thus, in order to raise the low mathematical achievement levels of African American students, different and innovative teaching strategies must be implemented.

Many scholars argue that African American students require pedagogy built on their thinking and experiences (Baugh 1994, Ladson-Billings 1992, Stanic 1991, Tate, 1994). This emerging instruction, called culturally responsive pedagogy, examines pedagogical strategies that build on the thinking, experiences, and traditions of African American

responsive pedagogy is to make mathematics relevant to students by making connections between the mathematics taught in school and the lives of the students. Addressing the mathematics equity problem for African American students was the impetus for the researcher to explore the applicability of a culturally responsive pedagogy in mathematics.

This study was undertaken to investigate whether employing a culturally responsive pedagogy would increase the mathematical achievement level of sixth grade African American students and change their attitudes toward mathematics. Two research questions were raised: 1) Is the use of culturally responsive pedagogical strategies effective in increasing the mathematical achievement of sixth grade African American urban students? 2) Do African American students who are taught using culturally responsive pedagogy have more positive attitudes toward mathematics than students taught using traditional methodology?

Forty-six students participated in the twelve-week study during the fall of 1997. Two sixth grade classes were selected for the study with one class designated as the treatment group and the other class the control group. Both groups were taught by the researcher and received the same mathematics content; the treatment group was taught using culturally responsive pedagogy. The students in the treatment group engaged in culturally responsive activities and were instructed using culturally responsive strategies including cooperative group work; open-ended problem solving connected to students' lives; and investigative research throughout the learning process. The research design of the investigation was a pre-test post-test control group design. The assessment instruments used were the Quasar Cognitive Assessment Instrument and the Quasar

Mathematics Attitude Survey.

In order to fulfill the purpose of this study, two null hypotheses were formulated and tested:

Ho: 1 There is no statistically significant difference in the mathematics achievement of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Cognitive Assessment Instrument.

Ho: 2 There is no statistically significant difference in the mathematics attitudes of students who are taught mathematics through culturally responsive pedagogy and students who are taught mathematics through pedagogy that is not culturally responsive as measured by the Quasar Mathematics Attitude Survey.

Summary of Related Literature

Major findings from related literature are summarized below:

1. American students perform more poorly in mathematics than do students in other major industrial nations. When compared to their white and Asian American counterparts, a disproportionately high percentage of African American students are not achieving competitively in mathematics (Secada 1992, Oakes 1990, Malloy 1997, Stiff and Harvey 1988).
2. Current reform efforts have emphasized the need to change the way mathematics is taught and learned so that all students have access to a mathematics education that is rich in opportunities for thinking, reasoning, and problem solving (Gilbert and Gay 1985).

3. In the past two decades, numerous studies have investigated the skills students need in mathematics - specifically, problem solving. These studies have traditionally examined majority students and typically excluded data for African American students (Tate 1995).
4. The failure of many mathematics educators to recognize, understand, and use African American students' culture in instruction results in many African American students finding the school culture alienating and inconsistent with their cultural experiences, hopes, dreams, and struggles (Villegas 1992, Tate 1995, Stiff 1995).
5. Culturally responsive mathematics pedagogy is predicated on the teacher's interpreting, understanding, and recognizing the students' culture and integrating it into the learning process; the teacher's allowing students to construct mathematical knowledge on the basis of their experiences; and effective classroom practice (Tate 1995, Ladson-Billings 1995, Malloy 1997).

Summary of Findings from the Analysis of Data

Two null hypotheses were tested using the two-tailed t-test for unequal samples. The following statements are the major findings which were drawn from the analysis and interpretation of data presented in the preceding chapter.

1. There was no statistically difference between the means of the post-test of the treatment and control group as measured by the Quasar Cognitive Assessment Instrument. However the treatment group showed greater pretest

post-test gain than the control group. The null hypothesis was therefore retained.

2. There was a statistically significant difference between the post-test attitudes of the control and treatment group as measured by the Quasar Mathematics Attitude Survey. The null hypothesis was rejected.

Conclusions

The conclusions based on the findings of this study are noted below:

1. The retention of null hypothesis 1 in this study indicated that the use of a culturally responsive pedagogy did not contribute to a greater increase in the mathematical achievement of the sixth grade African American students in this study.
2. The rejection of null hypothesis 2 led to the conclusion that culturally responsive pedagogy promoted positive attitudes toward mathematics of the sixth grade African American students in this study.

Implications and Discussion

The retention of the null hypothesis regarding students' mathematics achievement indicates that the use of culturally responsive pedagogy enabled students to achieve gains at a level comparable to their counterparts who received traditional instruction. The method of instruction (CRP) was new to the students and the majority of the students likely needed a longer period to adjust to this type instruction. It appeared that making connections between students' experiences and the curriculum required a longer period of time for the teaching and learning process to be affected. Teachers should be consistent in using instructional strategies such as cooperative learning, hands-on mathematics activities

different from those traditionally used in the classroom; however, persistent use of culturally responsive pedagogy should get students acclimated and accustomed to this type of instruction. Research indicates that strategies that de-emphasize the traditional lecture and emphasize hands-on mathematics exercises and culture based activities can have a positive impact on the learning process (Beckum, Zimmy and Fox 1989). These activities help teachers bridge the gap between cultural and mathematical differences.

Further, research literature shows a high correlation between successful academic performance of minority students and educators' sensitivity (attitudes and beliefs), knowledge of cultures, and application of cultural information (Nel 1992). The results of Nel's (1992) study indicated that cultural sensitivity plays an integral role in the learning process. Teachers with a heightened level of cultural sensitivity realized a need to promote instruction that would actively involve minority students. This awareness can have a profound effect on the self-image and confidence of African American mathematics students. This researcher felt a need to investigate culturally responsive pedagogical strategies after having developed an awareness of the cultural backgrounds of her students. As a result, her classroom experiences led her to integrate culturally related materials coupled with other instructional strategies that have been found to be effective with urban students. Once teachers are sensitive to the cultural backgrounds of their students, they are able to make pedagogical decisions that enrich instruction and enhance the academic achievement of students from diverse backgrounds, particularly African American students. Thus, the use of a culturally responsive mathematics pedagogy is likely predicated on the teacher's interpreting, understanding, and recognizing students' culture and integrating it

into the learning process; the teacher's allowing students to construct mathematical knowledge on the basis of their experiences; and effective classroom practice.

The significant difference in the mathematics attitudes of the sixth grade African American students in this study supports current research which has shown that attitude does play a role in students' mathematics achievement. It was clear that some students had little knowledge of how mathematics played an integral part of their everyday lives and how it can positively impact their futures. Even students who had not been very successful in mathematics began to put forth more effort in learning and understanding mathematics. The study suggests that culturally responsive pedagogy helps to create an environment which promotes students' enjoyment of mathematics.

The findings of this study support culturally responsive pedagogy as a strategy which has the potential to increase mathematics achievement and foster positive attitudes of middle grades African American students in urban school settings.

Recommendations

The following recommendations are supported by the analysis and interpretation of findings from the study and relate to practice, research, and policy.

1. The theoretical position regarding culturally responsive pedagogy should be a starting point for teachers in the development of mathematics programs for urban African American middle graders.
2. Mathematics curriculum for urban African American middle graders should integrate culturally responsive educational practices that build on the language and culture of the students.

3. For practitioners, this research reinforces the belief or position that the place to find out about classroom practices is the naturalistic setting of the classroom and from the lived experiences of teachers. Teachers of urban African American middle grade students need to conduct their own research into culturally responsive pedagogy.
4. Policies should be developed to ensure that teacher education programs in mathematics include culturally responsive mathematics pedagogy for diverse learners.
5. Atlanta Public Schools should use applicants' understanding of culturally responsive pedagogy as a criterion in new teacher selection for mathematics.
6. This study should be replicated over a longer period of time to measure the long term impact of culturally responsive pedagogy on the mathematical achievement of African American middle grade students in urban schools.

APPENDIX 1

LESSON PLAN

SUBJECT: MATHEMATICS

TOPIC: PROBLEM SOLVING STRATEGIES
GRADE LEVEL: SIXTH
TIME PERIOD: 5 DAYS

Day 1

Objective: Students will be able to:
(1) Use logical reasoning to solve problems
(2) Add, subtract, multiply and divide whole numbers and decimals
(3) Write explanations to problem solutions

Materials: Logic Anyone? Resource book, Mathematical Connections teacher's edition

Procedure: Lesson Opener: Sponge activity – Math puzzle

A. The teacher will build background by asking students the following questions:

(1) What it would be like to live in the 21st century? (2) What is the influence of calculators and computers on our daily lives? (3) What is the importance of thinking mathematically? (4) How do we use mathematics today and how we will use it in the future? (5) Why is it important to solve problems logically?

B. Next, the teacher will pose logic problem to the class, for example:

"You are offered a summer job at Six Flags. Your salary will be $1.00 for the first day, $2.00 for the second, $4.00 for the third, $8.00 for the fourth day, and so on. How much will you receive on the 20th day? How much will you receive for 20 days of work?

The teacher then encourages students to try different methods of approaching problem solving. Students will then make predictions of how much they would

APPENDIX 1 (cont.)

C. receive after working 20 days before doing any calculations. Students will then explain their reasoning underlying their solution to the problem. Then students will discuss how well their predictions compared to the answer. Next, the teacher should divide the class into cooperative groups. Students will then work in cooperative groups to solve logic problems, analogies and word problem sets. Then have students write two problems using one of the logic problems learned today.

Assessment: Oral and written responses, class participation

Day 2

Objective: Students will be able to:
(1) Use problem solving and logical reasoning skills to find solutions to word problems.
(2) Write explanations to solutions found.

Materials: Logic Anyone? and Mathematical Connections.

Procedure: Lesson Opener – Math puzzle

Teacher will: (1) Divide class into cooperative groups; (2) Pass out word problem task sheets to each group; (3) Go over the first problem with class and discuss. For example, Problem 1 reads: Keisha went to the mall. She left her house at 11:00 a.m. on Saturday and went to 6 stores. She spent between 20 to 30 minutes at each store. Altogether, it took her one hour to get from the bus stop to her house. She spent 15 minutes riding the bus home. What time did she get home? Explain.

The teacher will then discuss with students that there are several methods to solving problems and that no one method is correct. Have each group orally present their solutions to the problem. Then have students refer to the busy bus problem. Have students solve the problem with a written explanation. Emphasize to students that the important part of solving word problems is the reasoning or logical process involved in the solution. Once groups have completed the problem, have each group present orally their solution to the problem. Next, have each group write a word problem involving some aspect of their daily life.

APPENDIX 1 (cont.)

Have students play African game "Wari." Show students how to use logical reasoning skills to outwit opponents to win the game.

Assessment: Oral and written responses, word problems

Day 3

Objective(s): Students will be able to:
(1) Make magic squares
(2) Write an explanation to why magic squares work

Procedure: Teacher will divide class into cooperative groups. Provide each group with two sets of numbers. Have each group find the next three numbers in each sequence.

Have students discuss their explanation and provide similar examples. Display a picture of a magic square on the overhead. Have students complete the square. Have students make guesses as to why each column has the same sum. Explain the process. Discuss ex. 1-3 in Connections book. Next model how to make a magic square from an example magic. Discuss African Muhammad ibn Muhammad's contribution to magic squares and its relationship to the game of chess. Give examples of his magic squares. Have students work in cooperative groups to make a magic square. Have students share their magic squares and explanations as to why magic squares work.

Assessment: Oral and written responses, magic squares

Day 4

Objective(s): Students will be able to:
(1) Find the area and perimeter of different shapes
(2) Design a figure using prescribed measurements

Materials: geoboards, rubberbands, square tiles, African material, grid paper, scissors, construction paper, Covering and Surrounding (Connected mathematics project)

APPENDIX 1 (cont.)

Procedure: Teacher will model making various geometric shapes using geoboard and rubberbands. Ask students to model different shapes as you call out the dimensions. For example: How do you model a rectangle that has a length of 4 units and a width of 3 units? Have students use the square tiles to model the same measurements. Create a design using the square tiles and explain the design. Explain to students that there are two numbers that tell important information about the size of the designs you made: The total number of tiles used to cover the floor plan tell the area of the shape. The number of wall sections tells the total length of the outside wall surrounding the room, which is the perimeter of the room. Complete problems 1-3 in cooperative groups. Next have each group draw a rectangle with an area of 12 sq. units, 16 sq. units, and 20 sq. units from cardboard. Students are to create a floor design using pieces of African cloth, write an explanation of the design created and explain its measurements.

Assessment: Oral and written responses, African floor design

Day 5

Objective(s): Students will be able to:
(1) Find the area and perimeter of odd shapes and sizes
(2) Use estimation skills to find the area of odd shapes and sizes

Materials: Covering and Surrounding (Connected mathematics project), square tiles, grid paper, centimeter grid paper, yarn.

Procedure: Show and discuss examples of areas that would be considered irregular (various shapes). In pairs, have one student cut out an irregular shape. Have the second student trace the shape on grid paper. Then have both students agree on the number of whole squares and partial squares inside the shape. Students will use knowledge of underestimate and overestimate to arrive at their answer (Teacher may need to review concepts of underestimate and overestimate). Then have students find an underestimate and overestimate for the area of irregular shapes.

Problem solving activity-Pose this problem to students in which they need to find the area of an irregularly shaped figure. You are in charge of the landscaping for your

apartment unit. The residents of your unit want to cover an oval area in the front of the apartment with one-foot square blocks. Have students discuss different ways to determine the number of square blocks needed and draw an illustration of their plan.

Assessment: Oral and written responses, Illustration of floor plan

APPENDIX 2

LESSON PLAN

SUBJECT: MATHEMATICS

TOPIC: EGYPTIAN NUMERALS
GRADE LEVEL: SIXTH
TIME PERIOD: 2 WEEKS

Day 1

Objective(s): Students will be able to:
(1) Recognize Egyptian numbers;
(2) Identify each symbol and what it stands for in American numerals;
(3) Promote respect for all cultures and their contributions to mathematics;
(4) Increase students' awareness of ancient Egyptian society and its contribution to the modern world.

Materials: drawing paper, pencils, paper, markers, map of Africa

Procedure: Have students refer to map of Africa in front of room. Have one student point out Egypt on the map. After students have located Egypt on the map, teacher will give students background information about Egyptian numbers. Students will create their personal hieroglyphics chart. Students will complete practice drill using chart. Write the following drill in hieroglyphics.

a. 18_____

b. 60_____

Using Egyptian numerals, student will write their date of birth, number of boys and girls in the class, number of students wearing red, number of students wearing Nikes, number of students with the same favorite movie. Compare your Egyptian numbers with a partner. How are they the same or different?

Assessment: Oral and written responses, observations, class participation

APPENDIX 2 (cont.)

Day 2

Objective(s): (1) Estimate numbers by using rounding
(2) Write hieroglyphics for rounded numbers

Materials: pencils, paper, textbook, hieroglyphics chart

Procedure: Teacher will re-teach rounding skill on board . <----------> 30 39 40

Using a hieroglyphics chart, the teacher will demonstrate rounding numbers to the nearest ten.

19 = 20 ----------→ |||||||||∩□∩

13 = 10 ----------→ |||∩□∩

5 = 10 ----------→ |||||∩

∪

□ means equal.

Students will apply learned materials of rounding numbers. Given four problems on the board, students will round each number then write the answer in hieroglyphics. Compare answers with a partner.

Write five sets of three digit numbers. Have partners round the number to the nearest hundred, then write the Egyptian form. Also, have students round to the nearest thousand and write it in Egyptian form.

Assessment: Teacher observation, pupil participation

Day 3

Objective(s): Students will be able to:
(1) Solve addition problem using hieroglyphics

APPENDIX 2(cont.)

Materials: sentence strips, markers, pencil, paper, scissors

Procedure: Teacher and students will review associative properties of addition. Teacher will demonstrate adding with hieroglyphics and share with the class that you must tally the bones. (1) Base 10 allows only 9 units so you must carry 10 leaving 2. Always line up your symbols. 23 + 39 = 62.

Students will (1)create their own addition equations using two digit numbers written in hieroglyphics; (2)cut sentence strips into three sections and write the equations on sentence strips; (3) exchange and challenge a partner to complete the equations in hieroglyphics; (4)Compare your partner's answers with your answer. Finally, students will share equations on the board. For homework, students are to complete extension sheet –"Writing Egyptian numbers."

Assessment: Class participation, oral and written responses, observation

Days 4-6

Objective(s): (1) Analyze different ways of expressing fractions,
(2) Add and subtract fractions

Materials: Map of Africa, index cards, Egyptian fractions worksheet

Procedure: Pass out index cards with Egyptian fractions (symbols) on them to students. Have students guess what these symbols mean. Write the fraction ¼ on the board and ask students if the cards they have are similar to this fraction amount. Ask students how they think the symbols and the fractions are related. Discuss students reasoning. Lead a discussion with the class on how Egyptians used fractions to weigh and measure things, especially in distribution (such as loaves of bread to workers) or collection (such as goods collected as taxes). Have students explain how they think these circumstances may have resulted in the use of unit fractions. Point out that the Egyptians may have

thought in terms of parts of things. For example, if 12 workers were to equally share a number of bread loaves, a scribe might write the fraction symbol over the symbol for 12 to show that the loaves were to be distributed in 12 parts. If one worker was to receive more than one part, this might be indicated by showing the unit fraction for each part he was to receive.

Next discuss each symbol used in ancient Egyptian fractions. To express unit fractions, ancient Egyptians used the symbol for "month"(). When used in a math context, this symbol meant "part" and was placed above the denominator. Straight lines (|) represented numbers up to nine. A symbol that looked like the heel of a foot (∩) represented the number 10. By combining these symbols different fractions could be written. Have students express fractions as Egyptian fractions. Students are to divided their paper in half into two columns. Label one column fractions and the other Egyptian fractions. Next write Egyptian fractions for 1/7, 1/9 and 1/10 on the board. Ask students to identify the pattern. Have students orally explain the pattern.

Problem solving activity in cooperative groups:

Fractions in Egypt worksheet

(1) Work with your group and see if you can extend the table;
(2) Record your strategies on the back of this page
(3) Describe the algorithms you used to accomplish the task
(4) What limitations are imposed by using only unit fractions? How could the Egyptians have discovered a way to complete the table?

Assessment: Oral and written responses, rubric scale

Days 7-10

Objective(s): (1) Multiply fractions and mixed numbers
(2) Analyze, make and use drawing to solve problems
(3) Explore the diversity of food from the African American culture

Materials: construction paper, rulers, crayons, markers, African American recipes

APPENDIX 2 (cont.)

Procedure: Teacher will review how to multiply fractions. Tell students that their assignment over the next three days will be to make an African American recipe book. They are to use family recipes, or look in African American magazines for recipes to use in their book. Then they are to select ten recipes, including a favorite cookie recipe. They are to also include pictures or drawings of the food included in the book. They are to increase each recipe to feed 10 people. Teacher will demonstrate how to increase the fraction amount by using multiplication. For example, use a recipe from Ebony magazine. Go over the recipe with students and demonstrate how to change the fractions to include more people.

Problem solving activity: "How to satisfy everyone"

Students are to work in cooperative groups to solve the pizza problem solving activity, page 283 in textbook. Then have students make up a pizza problem similar to the one they just solved. Have students check their problems to be sure it can be solved and then exchange it with another group.

Assessment: African American recipe books, oral and written responses, class participation.

APPENDIX 3

Lesson Plan

Subject: Mathematics

Theme: Africa – "Discovering your Roots"
Grade Level: Sixth
TIME PERIOD: Four Weeks

Overview

This unit integrates language arts, mathematics, basic geography, African culture, history, and geography, and technology as students learn about Africa. Students are to select an African country and plan a trip to that country from Atlanta. In this lesson, students will learn that problem solving is an essential real-life skill. They will calculate distances between Atlanta and their chosen African country and determine the costs of travel, lodging, food, etc. Also students will be given problem solving packets to work on with their projects. In addition, this lesson provides an opportunity to utilize information-gathering technology such as CD-ROM databases and the Internet. Decision making skills and cooperative learning are utilized extensively throughout this unit.

This unit will need at least 3-4 weeks to complete.

Objectives

In small groups, students will be able to:

1. Plan their itinerary.
2. Estimate distances and travel times between points on their itinerary.
3. Calculate mileage between destinations on a map.
4. Prepare two budgets (one economical and the other more generous) for their segment of the trip.
5. Design a Powerpoint presentation.
6. Research points of interest along their travel route.
7. Research, request, and gather information about their destination via the Internet, CD-ROM databases, and International Embassies.
8. Orally present project to class.
9. Create a travel brochure to share as part of their presentation.

APPENDIX 3 (cont.)

10. Make and design an African Kufi hat using the formula for circumference.
11. Use data on Africa and U.S. to solve word problems.
12. Explore patterns and designs in African art.
13. Make fraction flags.

NCTM Standard for Grades 5-8 addressed in the lesson:

Standard 5: Understand, represent, and use numbers in a variety of equivalent forms in real-world and mathematical problem solving situations.

Materials

- Individual 8.5" x 11" world maps (one per students)
- Online or CD-ROM U.S. atlas
- Computers
- African fabric
- Glue
- Scissors
- Card board
- Postcards
- Rectangular sheets of construction paper in light or medium shades
- Rulers
- Straws, wooden skewers, or dowels for the "flag poles"

Procedure: Students begin the class in a whole group setting. The teacher introduces the lesson by asking students to define cultural group. Teacher has students identify some examples of cultural groups. Next have students identify the cultural group to which they belong. Teacher refers to the map of Africa and reads some names of the countries to the students. Have a discussion on some of the common customs of the peoples of Africa and African Americas, i.e. food, clothes, etc. Show students a Kufi hat as an example of African culture that is part of African American dress today. Explain to students that part of their African culture project will be to make and design a Kufi hat for themselves. Also part of their project will be to select items such as food, clothing, art, music, natural

resources, religion, etc. that are reflective of their designated African country to include in their travel brochure.

Inform students that they will be working in small groups of 2-3 students. Each group will plan a trip to Africa. Students are to select a country of their interest. The groups should have a clear idea of their itinerary before they begin their research. Tell the students how much money each group's budget contains for the trip.

Before getting in groups, show the students a video clip as an anticipatory set. The video could discuss distances between places, converting miles to kilometers, or other map skills, which use math as the basic ingredient. Students are also to find the population, area, and distance from Atlanta to selected country.

Students will conduct their projects in cooperative groups rotating through different stations. The students' task at each station is designed to integrate writing, problem solving, cooperative, technology and critical thinking skills in the mathematics curriculum. Students will have task cards for each station so they will know precisely what is expected of them during their time at that station. The instruction in this activity is student-centered. The teacher's role is that of "facilitator." That is, the teacher helps the students find out what they need to know and circulates around the room assisting students to do what they think needs to be done.

Station #1 Telecommunications

Students will go online to gather information on their selected countries via Internet, CD-ROM, or by visiting various web sites. (This takes place in the classroom and the library). They will gather information such as lodging costs, gas prices, places to visit, speed limits and distances between destinations on each leg of the trip. They should decide what information they need for their planning.

Station #2 CD-ROM Databases

Using CD-ROM reference materials, students will calculate mileage, and they will use mileage information to estimate other cots of traveling such as gas, lodging, and food. They will also use reference materials to gather tourist attraction information.

APPENDIX 3 (cont.)

Station #3 Mathematics

Students will use information gathered on their country to answer questions related to project. (i.e. calculate price per mile, food costs per day, etc.)

Station #4 Powerpoint

Powerpoint is presentation software. At this station, each group will design a Powerpoint presentation for their oral presentation.

Station #5 Travel Itinerary

Students will map out travel plans on individual maps. This activity is the first step towards creating a travel brochure to share as part of their presentation. Later, their maps can be scanned and used in their brochures.

Station #6 Fraction Flags

Students will make a flag of their country using fractions. Students will illustrate the fraction amount on the front of the flag.

Station # 7 Kufi Hat Designs

Students will make and design Kufi hats using the formula for circumference. Later, students will dress in African clothes with their Kufi hats for their presentations.

Assessment: Observe the students during each station and monitor their progress while they are working in groups designing their project.
Problem solving packets completed by each group.
Power point presentation and oral presentation of African culture project.

APPENDIX 4

Quasar Mathematics Survey

How much do you agree with the following statements? Place an x in the column which indicates how you feel about each statement.

SA-Strongly Agree A-Agree U-Undecided D-Disagree SD-Strongly Disagree

	STATEMENTS	SA	A	U	D	SD
1.	Mathematics is my favorite subject in school.					
2.	Everyone should study mathematics in high school.					
3.	All mathematics courses are difficult for me.					
4.	Mathematics is necessary and useful for my daily activities.					
5.	I dislike mathematics in any form.					
6.	Doing mathematics homework is a waste of my time.					
7.	Mathematics is interesting to me.					
8.	Mathematics is my worst subject.					
9.	I will take a math course each year in high school.					
10.	I enjoy mathematics because it is interesting and challenging.					
11.	I find mathematics boring.					
12.	Mathematics is easy to me.					

APPENDIX 4 (cont.)

13. I never use mathematics except in my math class.

14. I enjoy solving mathematics problems during my spare time.

15. No one should have to study mathematics in school.

16. Anyone who like math is strange.

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